DEPARTMENT OF NATURAL RESOURCES
WATER PROTECTION PROGRAM
WATER QUALITY MONITORING AND ASSESSMENT SECTION
WATERSHED INFORMATION SHEET

Lake of the Ozarks Basin-10290109

Basin Description

The Lake of the Ozarks Basin consists of the area of central Missouri drained by all the tributaries of the Lake of the Ozarks, except for the Niangua and Little Niangua rivers and the Harry S Truman Reservoir and its tributaries. This basin covers approximately 1,385 square miles. The Lake of the Ozarks was created in 1931 with the completion of Bagnell Dam on the Osage River, near the town of Lake Ozark. The lake has a maximum surface area of 60,000 acres and capacity of 1,218,000 acre-feet. It extends 90 river miles from Bagnell Dam to the Truman Dam, near Warsaw. Much of its shoreline and the surrounding area are heavily developed for residential and commercial purposes. The lake itself is used heavily for fishing, boating and other recreation. The Lake of the Ozarks is not used as a source of drinking water, and no other surface waters in the basin are used for public drinking water supply.

Major tributaries of the lake include Mill Creek, Soap Creek, Gravois Creek, Little Gravois Creek, Little Buffalo Creek, Big Buffalo Creek, Knobby Creek, Deer Creek, Brushy Creek, Cole Camp Creek, Big Turkey Creek, and Grand Glaize Creek, formed by the confluence of Dry Auglaize Creek and Wet Glaize Creek. The $7Q_{10}$ low flow (the lowest average flow for a seven-day period that may be expected in a typical ten-year period) for Little Gravois Creek at Bagnell is 0.4 cfs (cubic feet per second). For Wet Glaize Creek near Brumley, it is 12 cfs, and for Grand Glaize Creek near Brumley, it is 16 cfs. The mean flow of the Osage River below Truman Dam from 1982 to 2001 was 11,040 cfs. Average annual precipitation varies from 41 inches in the northwestern part of the basin to 43 inches in the southern part.

The Lake of the Ozarks basin lies almost entirely within the Ozark Highlands physiographic province. Most of the basin is hilly, and the hills surrounding the eastern and central portions of the lake can be very rugged. There are somewhat flatter uplands in the southern portion of the basin, containing thin, highly erodible, rocky or cherty soils. Fifty-nine percent of the basin is forest or woodland, thirty-four percent is pasture or grassland, five percent is open water, one percent is cropland, confined to valley bottoms with comparatively deep soils, and one percent is considered urbanized.

The basin lies in Ordovician dolomite and sandstone, much of which has been deeply incised by streamflow. There is also a great deal of groundwater flow, due to the soluble

dolomite bedrock. Springs and caves are plentiful in the lower elevations around the lake and some of its tributaries, although many are now inundated. There are still at least 62 known springs in the basin. Those with mean flows of at least one cubic foot per second (cfs) are listed in Table 1.

Table 1. Major Springs in the Lake of the Ozarks Basin

Spring Name	County	Mean Flow (cfs)
Armstrong Spring (E)	Camden	11.6
Blue Hole Spring	Camden	7.2
Wet Glaize Spring	Camden	7.0
Gravois Mill Spring	Morgan	6.0
Toronto Spring	Camden	5.2
Armstrong Spring (W)	Camden	1.6
Boylers Mill Spring	Morgan	1.4

Dry Auglaize Creek and its major tributary, Goodwin Hollow, flow through a karst plain. Large segments of these two streams rarely contain water and any water conveyed to them enters the groundwater system. This water then moves westward and emerges in the Niangua River basin. Dye traces have linked Goodwin Hollow to Bennett Spring and Dry Auglaize Creek to Blue and Ha Ha Tonka springs. Some water lost from Dry Auglaize Creek may flow to the Wet Glaize Creek basin to the east.

Water Quality Concerns

Acceptable water quality is defined by Missouri's Water Quality Standards [http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7a.pdf]. Streams or lakes that do not meet these standards are considered "impaired". They may not be fit for certain uses, such as swimming, drinking water supply, or protection of fish and other aquatic life. Waters are considered to be "affected" rather than "impaired" if water quality changes are less serious and state standards are not exceeded. These standards also list over 3600 classified streams and over 400 classified lakes in the state. A classified stream is one that is either a permanently flowing stream or one that may stop flowing in dry weather but still maintains large pools of water that support aquatic life. Unclassified streams are the small tributaries to classified streams that do not typically maintain pools capable of supporting aquatic life for the entire year.

Point Source Pollution

Point source pollution is a discharge of wastewater from a single location such as a wastewater treatment plant. Wastewater treatment plants can serve industries, small businesses, subdivisions, mobile home parks, apartment complexes, or entire cities. Wastewater from residential sources such as subdivisions, apartments and mobile home parks is often referred to as "domestic wastewater" and contains primarily treated human wastes, food wastes and detergents. The primary pollutants of concern in domestic

wastewater are the amount of organic matter, which is commonly reported as biological oxygen demand (BOD), suspended solids, and ammonia. Industrial and commercial wastewater can be more complex and may contain, in addition to domestic wastes, heavy metals or man-made organic chemicals that can be potentially toxic. Discharges from most municipal wastewater treatment plants are usually a mixture of domestic and industrial/commercial wastewater. Most wastewater plant discharges are also typically high in nitrogen and phosphorus, two elements that act as fertilizers and can cause excessive algae growth in waters receiving these discharges.

There are 255 permitted domestic, industrial, or commercial point sources that discharge a combined 5.26 million gallons per day (mgd) of treated wastewater into the waters of the Lake of the Ozarks basin. By far the largest is the wastewater treatment facility of the city of Lebanon, at 1.83 mgd, or 35 percent of the total wastewater discharging to the basin. There are 251 miles of classified stream in the basin, 1.2 miles (less than one percent) of which are known to be impaired or affected by point source wastewater discharges. Point source discharges also impair or affect 0.8 miles of unclassified streams in the basin. The only point source impairing or affecting 0.5 miles of stream or more is the Lebanon WWTP, which partially impairs 1.0 miles of Dry Auglaize Creek. There have also been numerous sewage bypasses near the plant in recent years. The Water Quality Management section below gives more information on the Lebanon WWTP and what is being done to address its problems.

Small domestic and commercial point source discharges have proliferated around the lake as development has increased. The low elevation of these sources makes the construction of sewers to collect and centrally treat their wastewater extremely difficult. The large number of sources makes it very difficult to ensure that all the wastewater discharged to the lake is treated effectively. Currently, the lake is rich in nitrogen and phosphorus, due largely to the many point and nonpoint sources close around the lake. These nutrients have led to excessive algae growth in the lake. Nutrient and algal levels are generally highest in shallower portions of the lake, due to the influence of developed areas, the discharge from Truman Dam, and other streams entering the lake. Also, tests for fecal coliform bacteria in the lake have consistently found levels below Missouri's water quality standard for whole-body contact.

Wastewater Treatment
http://www.dnr.mo.gov/env/wpp/watersheds/info/wastewater-treatment.pdf

Nonpoint Source Pollution

Nonpoint source pollution occurs when pollutants enter bodies of water at points that are not well-defined and stable. Examples include the erosion of sediments or the entrance of polluted surface runoff or groundwater into lakes and streams. Locations of nonpoint source pollution are often widely dispersed and are difficult to identify or control.

In the Lake of the Ozarks basin, a major nonpoint source problem is the influence of the development surrounding the lake. Many domestic and commercial septic tanks surround the lake, and they also contribute nutrients to the lake that are likely to cause algae

growth. Fertilizers used on lawns near the lake also leach or run off into the lake and contribute to this problem.

The construction of Truman Dam greatly reduced the amounts of sediment and nutrients entering the lake from the Osage River. However, it has also caused some problems. Discharge from the dam can occasionally be low in dissolved oxygen, or high in dissolved atmospheric gases. High-velocity discharges of water may also cause stress to fish in the upper part of the Lake of the Ozarks. It is unclear how frequently these problems occur, but effects on fish below the dam have been noted, and a small portion of the lake below Truman Dam has been placed on Missouri's list of impaired waters.

In the area of the Dry Auglaize Creek watershed, a high potential exists for contamination of groundwater. Given the extremely porous and fractured geology of the area, contaminated surface water could quickly sink into underground water sources with a minimum of natural filtration. Care must be taken to drill wells deeply and securely so that the chances of rapid contamination of the groundwater supply are minimized.

Water Quality Management

The department achieves water quality management of point source pollutants through the issuance and enforcement of wastewater discharge permits. These permits limit the amount of pollutants that can be discharged. All point source wastewater dischargers must obtain a permit and adhere to its discharge limitations. All permits require a level of treatment at least equal to national wastewater treatment standards. In situations where these national treatment standards are not adequate to protect the streams or lakes receiving wastewater discharges, stricter permit limits that do protect these waters are required. The Department requires dischargers to conduct regular monitoring of discharge quality and report their results. The department also conducts regular inspections of wastewater treatment facilities and receiving waters.

The Lebanon WWTP has had difficulties for many years. Its permit expired in 1997, and the department continues to work to create a new permit while the conditions of the old permit remain in effect. The poor quality of effluent has mostly been corrected, and the plant must adhere to strict advanced treatment standards due to the losing nature of its receiving stream. Aquatic life in Dry Auglaize Creek remains impacted, however, due to the streamflow being nearly one hundred percent effluent. The Lebanon plant's range of impact upon Dry Auglaize Creek is limited by the fact that it is such a rapidly losing stream, but as was mentioned in the basin description, the waters of this stream flow through the subsurface water system to the springs of the Niangua basin. Finally, sewage bypasses have been common for several years at a manhole just above the Lebanon plant. These bypasses are a serious concern, and are believed to be caused by intake and infiltration (I&I) problems with the city's sewer. The city of Lebanon has studied the problem and is working with the department to fund and implement the necessary

improvements. Also, a consent judgement is being negotiated between the plant and the U.S. Department of Justice that will address violations at the plant.

Nonpoint source pollution is addressed through the state's nonpoint source management plan. This plan is a cooperative project between the Missouri Department of Natural Resources and many other federal, state, and local government agencies, organizations, local landowners, and other interested citizens. The plan emphasizes addressing problems at the watershed level through the use of management practices that control nonpoint source pollution. The most commonly supported practices are those that control soil erosion on tilled land, improve quality and quantity of forage on grazing lands, protect riparian zones, and control runoff of animal manures, fertilizers, and pesticides. The state nonpoint source management plan is a voluntary program that provides funds, in the form of grants, to help defray the cost of adopting improved management practices. The nonpoint source watershed management project that has taken place in this basin is described in Table 2.

Table 2. Nonpoint Source Watershed Projects in the Lake of the Ozarks Basin

Watershed Name	County	Project Date	Watershed Size (Acres)	Acres Needing Treatment	Acres Treated	Percent of Watershed Treated
Turkey Cr.	Hickory	1992-96	6,669	4,380	3,654	55

Water Quality Data Links

U.S. Geological Survey National Water Quality Information System

http://nwis.waterdata.usgs.gov/mo/nwis/qwdata